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NASA DENTAL PROGRAM FOR MANNED SPACE FLIGHT

The Dental Service at NASA's Manned Spacecraft Center has several broad functions, all of which are directed to preventing or solving oral health problems which might be or are related to manned space flight. These functional areas are (1) to provide clinical dental services for astronauts and military personnel assigned to the Manned Spacecraft Center, (2) to provide for inflight oral health needs, and (3) to identify and take steps toward the resolution of potential oral health problems in manned space flight. The Dental Service also provides consultant services to the Director, Life Sciences Directorate.

#### CLINICAL CARE OF ASTRONAUTS:

In providing clinical care for astronauts, the key emphasis is in keeping with the basic philosophy of our profession - the prevention of dental disease. All astronauts are appointed each six months for a dental evaluation, more often if needed. They are taught the methods of keeping their oral tissues clean and healthy, using toothbrush, paste, and dental floss. The same materials are provided inflight so that oral health can be maintained at a high level during space missions. Topical stannous fluorides are also used regularly to reduce the incidence of dental caries. The program has proven successful and the astronauts maintain a high level of general oral health. New carious lesions and periodontal problems are rare.

The materials and procedures used to treat NASA astronauts are those used conventionally by the dental profession. Silver alloy, gold, and composite resins are the restorative materials of choice. Crowns and fixed

partial dentures are provided patients when necessary. No problems have occurred with the use of these materials in our space missions to date.

The phenomenon of barodontalgia, sometimes known as aerodontalgia, was probably the first type of dental problem noted when man began flights to high altitudes. Barodontalgia can be described as a toothache, sometimes severe, which may occur when a subject is exposed to the reduced barometric pressures of high altitudes. It is estimated that at least 20% of fighter pilots experience this pain at some time during their flying careers. Through research, factors such as cold temperatures and air pockets (bubbles trapped under restorations) have been eliminated as etiologic factors in barodontalgia. While the exact mechanism remains unclear, it has been shown that barodontalgia is directly related to pathosis of the dental pulp. Pulpal inflammation due to restorative procedures or deep carious lesions are the most common etiologic factors. Periapical granulomas and periodontal abscesses have also been reported as factors in producing the sometimes severe discomfort of barodontalgia. Also, maxillary sinusitis and blockage of the middle ear have been indicted and must be included in the differential diagnosis. We have noted that with close evaluations of our patients and attention to minimizing injury to the dental pulp when providing our patients with dental restorations, this potential problem has been controlled. We have not had any problem with barodontalgia during manned space flights.

#### INFLIGHT ORAL HEALTH NEEDS:

Inflight, astronauts are provided with a toothbrush, dental floss and ingestible toothpaste. The toothbrush is soft, and the floss unwaxed

and thin. The toothpaste is ingestible because there is no provision to empty one's mouth in a spacecraft in the zero-G environment. The astronauts have all expressed their pleasure at having these items available to them during their space missions.

Americans have completed about 8,000 man hours of space flight to date and no inflight dental problems have occurred. No provisions were made for treating inflight dental problems through the Apollo program other than some analgesics and antibiotics being available in the medical kit. It was felt that the relatively short duration missions through the Apollo program entailed minimal risk. The Skylab program, however, with its significantly longer duration missions, presents a correspondingly greater risk of inflight dental problems.

Based on studies of man in other isolated environments (polar expeditions, atomic submarines, etc.) and long-term studies of the astronauts, a crewman is estimated at 1% for a 28-day, 3-man mission. This projected incidence is analogous to a man in excellent dental health having one such problem in 24 years. Skylab missions are planned for up to 56 days duration with 3 man crews. It is felt that a capability to treat inflight medical and dental problems during these missions is essential. To this end a medical and dental kit has been developed and a training program established. With sophisticated aids and ultimate direction and control from a dentist in Mission Control, astronauts will be able to treat many potential inflight dental problems. The most likely problems expected range from minor gingival disturbances to

severe toothache due to pulpitis in a previously restored tooth. Dental caries is not expected to be a problem because of the integrated clinical dental program at the Manned Spacecraft Center. To minimize the potential problem of pulpitis in a recently restored tooth, no dental restorations are accomplished for crewmembers for 90 days prior to a mission. Once again, the intensive dental program at the Manned Spacecraft Center makes this restriction feasible.

RESEARCH:

The Dental Service at NASA's Manned Spacecraft Center has instituted several research projects concerned with manned space flight.

In keeping with the current philosophy and research of our profession, we have undertaken intensive research, both quantitatively and qualitatively, investigating changes in the oral microflora of astronauts in the Skylab closed environmental system. This is being accomplished with the cooperation of the University of Texas, Dental Science Institute. Primates (marmosets) have been studied during a series of hypobaric missions lasting up to 56 days in length. The next phase of this project consists of a study of three astronauts during a 56 day hypobaric chamber isolation, and finally, in-depth studies of microbial samples from the crews before, and after the Skylab missions. These studies will be integrated with complete clinical observations pre- and post-flight of these same astronauts. The purpose of these studies ultimately is to confirm the personal oral hygiene procedures needed to maintain optimal dental health during prolonged manned spaceflight and to aid in documentation of cross contamination or illness events.

In conjunction with the Dental Sciences Division at the U.S. Air Force's School of Aerospace Medicine, a means has been developed for mixing a temporary dental restorative material in a zero-gravity environment.

The ingestible dentifrice used in all Apollo and Skylab flights was developed in the laboratories of the U.S. Air Force Dental Corps with final modifications provided by the Oral Physiology Research Laboratories of the Veterans Administration. It has been modified so that calcium content has been kept to a minimum because of ongoing mineral metabolism studies during manned space missions. Also, the foaming agents have been removed. It is interesting to note that this toothpaste has been used extensively in V.A. Hospitals for seriously debilitated patients - those unable to care for themselves. In a study accomplished in several V.A. Hospitals, both the patients and professional personnel were very enthusiastic at both the improvement in plaque scores for these patients and in increased interest in oral hygiene by these patients. The patients previously had severe dental problems and in this program were kept under control.

Another research project has involved more efficacious means of using stannous fluoride for topical application. To this end, an effort by the Oral Physiology Research Laboratories of the Veterans Administration has resulted in a product in which stannous fluoride is placed in a glycerine vehicle to form a water free compound in a gel state. This product may have implications for long duration space missions where this added fluoride protection may prove essential. It has been tested to date on the previously mentioned debilitated patients and also on

other patients unusually susceptible to dental caries, i.e., head and neck cancer patients who have received massive radiation for their neoplasms. Preliminary results of the use of the stannous fluoride gel to protect the teeth of these patients have been very encouraging.

Other areas in which studies are being accomplished include measurement of total body water loss by recovering deuterium oxide from parotid fluid, evaluation of the effects of radiation on the oral microbial population, and studies of the food for space missions, relating to its potential effect on oral health.

The efforts of the Dental Service are completely directed to minimizing the possibility of any deterioration of oral health during manned space flights. We are encouraged by our results to date. No deleterious effects on oral tissues have been observed, however we must remain alert to the possibility that should such undesirable effects occur, they could be difficult to detect and subtle in their effects. We believe we have made the first steps to detect any subtle changes, should they occur, and also to intercept them should they be judged a threat to the health of the oral tissues.